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IS 5834-1 (1994): Electrical Timer Relays for Industrial Purposes, Part 1: Pneumatic [ETD 35: Power Systems Relays]

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भाग 1 वायवीय

(पहला पुनरीक्षण)

Indian Standard

ELECTRICAL TIMER RELAYS FOR INDUSTRIAL PURPOSES — SPECIFICATION

PART 1 PNEUMATIC

(First Revision)

UDC 621·318·562·7

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 1994

Price Group 6

Power System Relays Sectional Committee, ET 35

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Power System Relays Sectional Committee had been approved by the Electrotechnical Division Council.

This Indian Standard (Part 1) was first published in 1973. This revision has been undertaken to bring it in line with IS 13947 (Part 5/Sec 1) : 1993 'Low voltage switchgear and controlgear: Part 5 Control circuit devices and switching elements, Section 1 Electrotechnical control circuit devices' read with IS 13947 (Part 1) : 1993 'Low-voltage switchgear and controlgear: Part 1 General rules' since the relays for industrial purposes covered in this standard will perform switching of inductive loads like contactor and relay coil similar to pilot devices covered in IS 13947 (Part 5/Sec 1) : 1993.

Electrical relays for industrial purposes are now being extensively used in various industries for control and other purposes. A number of industrial relays for such purposes is now being manufactured indigenously in India.

The timber relays for industrial purposes covered by other parts of this standard, IS 5834 'Electrical timber relays for industrial purposes', are:

Part 2 Motorized timer relays
Part 3 Electronic timer relays

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ELECTRICAL TIMER RELAYS FOR INDUSTRIAL PURPOSES — SPECIFICATION

PART 1 PNEUMATIC

(First Revision)

1 SCOPE

This Indian Standard (Part 1) covers pneumatic timer relays for providing steplessly adjustable time delay to control various types of industrial circuits of nominal voltage not exceeding 1 000 volts.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
13947 (Part 1) : 1993	Low-voltage switchgear and controlgear: Part 1 General rules
13947 (Part 5/Sec 1) : 1993	Low-voltage switchgear and controlgear: Part 5 Control circuit devices and switching elements, Section 1 Electromechanical control circuit devices

3 DEFINITIONS

3.0 For the purpose of this standard, the following definitions in addition to those given in IS 13947 (Part 5/Sec 1) shall apply.

3.1 Time Delay Relay

A relay whose operation or resetting is intentionally time-delayed. The time delay of the relay may be fixed or adjustable.

3.2 Time Delay Contact

A contact intended to be used for controlling an external circuit and operated by the time delay relay.

3.3 Instantaneous Contact

A contact working in conjunction with and actuated without any intentional time delay by relay and serving to control operation of auxiliary device(s).

3.4 Inoperative Condition

It is the condition of the relay and contacts when the relay coil is de-energized (for the 'on' delay relay) and energized (for the 'off' delay relay).

NOTES — Clauses **2.4.1.1** and **2.4.1.2** of IS 13947 (Part 5/Sec 1) : 1993 may also be applied to any type of contact element.

3.5 Number of Poles

A relay is called single pole, double pole, etc, or is designated one pole, two pole, etc, if the timed circuit of relay is divided into one pole, two pole, etc, insulated from each other, and that the poles are or can be coupled in such a a manner as to open or close together.

3.6 Rated Insulation Voltage

The value U_i of voltage assigned by the manufacturer by which the timer is designated and to which dielectric tests, clearances and creepage distances are referred.

3.7 Rated Operational Voltage

The value U_e of voltage assigned by the manufacturer which, in combination with a rated operational current, determines the application of the timer relay and to which the relevant tests and the utilization categories are referred. For polyphase circuits, U_e is stated as rms voltage between phases.

NOTE — A timer relay may be assigned a number of combinations of rated operational voltage and rated operational current.

3.8 Rated Control Circuit Voltage

A value U_c of voltage on which the operating and temperature-rise characteristics of the control circuit are based.

NOTES

1 The correct operating conditions are based upon a value of the control supply voltage not less than 85 percent of its rated value, with the highest of control circuit current flowing; not more than 110 percent of its rated value.

2 The manufacturer should be prepared to state the value or values of the current taken by the control circuit at the rated control supply voltage.

3.9 Rated Thermal Current

A value of current assigned by the manufacturer and limited by the temperature-rise as specified in **5.10**.

NOTE — *It is the maximum value of current which a contact installed under standard conditions of service, can carry continuously without damage.*

3.10 Rated Operational Current

Clause **4.3.2.3** of IS 13947 (Part 1): 1993 applies.

NOTE — A contact element may be assigned a number of combinations of rated operational voltage and rated operational current.

3.11 Rated Frequency

Clause **4.3.3** of IS 13947 (Part 1) : 1993 applies.

3.12 Rated Making Capacity

Clause **4.3.5.2** of IS 13947 (Part 1) : 1993 applies.

3.13 Rated Breaking Capacity

Clause **4.3.5.3** of IS 13947 (Part 1) : 1993 applies.

3.14 On Delay

'On Delay' signifies that the timing period of a time delay relay is initiated upon energization of its coil.

3.15 Off Delay

'Off Delay' signifies that the timing period of a time delay relay is initiated upon de-energization of its coil.

3.16 Time Delay

Time delay is the time interval between the energization (for the 'On' delay relay) or de-energization (for the 'Off' delay relay) of the relay coil and the actuation of the time delay contacts.

3.17 Repeat Accuracy

The repeat accuracy of a time delay relay is one half of the variation between the maximum and minimum observed operating times at any particular setting, divided by the mean of all the observed operating times and the quotient multiplied by 100 and expressed in terms of plus or minus percentage.

It is given by the following formula:

$$\text{Repeat accuracy} = \frac{1}{2}\left[\frac{(T_1 - T_2)}{\sum \frac{T}{n}}\right] \times 100 \text{ percent}$$

where

T_1 = maximum operating time in seconds,
T_2 = minimum operating time in seconds,
T = actual operating time in seconds for each, and
n = number of operations.

3.18 Type Tests

Tests carried out to prove conformity with the requirements of this specification. They are intended to prove general quality and design of a given type of relay.

3.19 Routine Tests

Tests carried out on each relay to check requirements likely to vary during production.

4 DESIGN AND CONSTRUCTION

4.1 General

4.1.1 Materials should be suitable for the particular application.

4.1.2 Parts which may require replacement shall be readily accessible and replaceable.

4.2 Enclosure

4.2.1 The relay may be housed in a separate enclosure or may be provided in open execution. The type of enclosure, if provided, shall be one of those covered by Appendix C of IS 13947 (Part 1) : 1993.

4.2.2 The enclosure, if provided, shall be so arranged that when it is opened, the terminals are readily accessible. Furthermore, sufficient space shall be left in the interior of the enclosure for the accommodation of the external conductors from their point of entry into the enclosures up to the terminals.

4.2.3 The cover of the protective enclosures, if provided shall be secured to its base that it cannot be accidentally loosened or detached owing to effects of operation of the relay. Also it should be so secured that it is not possible to open it without the use of tools, unless suitable means are provided to prevent accidental contact with live parts.

4.3 Earthing

4.3.1 The enclosures of relay, if of metal, shall be provided with one earthing terminal, for rated voltages not exceeding 250 V, and two separate earthing terminals for rated voltages more than 250 V. These terminals shall be provided over and above all other means provided for securing metallic enclosures (armour or other metallic covering) of current-carrying cables.

4.3.2 The earthing terminals shall be readily accessible and so placed that the earth connection of the relay maintained when the cover or any other movable part is removed.

4.3.3 The earthing terminals shall be of adequate size, be protected against corrosion and shall be metallically clean. Under no circumstances shall a movable metal part of the enclosure be insulated from the part carrying the earthing terminal when the movable part is in place.

4.3.4 The earthing terminal shall be identified by means of the symbol ⏚ marked in a legible and indelible manner on or adjacent to the terminal.

4.4 Clearances and Creepage Distances

See Annex G of IS 13947 (Part 1) : 1993.

4.5 Terminals

4.5.1 The terminals shall be of adequate size.

4.5.2 Terminal connections shall be such that conductors may be connected by means of screws or other equivalent means so as to ensure that the necessary contact pressure is maintained permanently.

4.6 Contacts

Simultaneous use of normally open contact and normally closed contact on the same pole shall be permissible only on the same polarity. Contacts shall be completely enclosed to prevent ingress of dust and other such elements. Contacts shall be of snap action type.

4.7 Means of Time Delay Setting

Relay shall be provided with a simple mechanism for steplessly adjusting the time delay of the relay. Such mechanism shall not require the use of any special tools for setting. Any time adjustment mechanism requiring rotary motion shall be so designed that the time interval increases with clockwise motion and decreases with anticlockwise motion. Direction of movement of the time adjusting mechanism shall be clearly marked to indicate the increase and decrease of the time setting of the relay.

4.8 General Operating Principle

General operating principle of the pneumatic time delay relays is given in Annex A.

4.9 It shall be possible to convert relays without auxiliary circuits from 'On Delay' to 'Off Delay' type and *vice versa* by the user without the use of any special tools or components.

5 RATINGS

5.1 Rated Operational Voltage

The rated operational voltage shall be one of the following values:

For ac — 110, 240 and 415 volts
For dc — 24, 48, 110 and 220 volts.

5.2 Rated Contact Circuit Voltage

The rated contact circuit voltage shall be one of the following values:

For ac — 110, 240 and 415 volts
For dc — 24, 48, 110 and 220 volts.

5.3 Rated Currents

5.3.1 The rated operational currents shall be 1, 2·5, 4, 6 and 10 A.

5.3.2 The rated thermal currents shall be 1, 2·5, 4, 6 and 10 A.

5.4 Rated Frequency

The rated frequency shall be the standard frequency of 50 Hz.

5.5 Rated Mechanical Duty Class

5.5.1 In respect of its resistance to mechanical wear a time relay shall be characterized by the number of no-load operating cycles which can be made without any mechanical failure. The stated number of no-load operating cycles assumes no maintenance, repair or replacement.

5.5.2 The relays are classified according to Table 1 in respect to their mechanical duty classes.

Table 1 Rated Mechanical Duty Class

(*Clauses* 5.6.2.1 *and* 9.8.1)

Class of Mechanical Endurance (1)	No-Load Operating Cycles (2)	Number of On-Load Operating Cycles per Hour (3)
0·3	$0·3 \times 10^6$	30
1	1×10^6	120
3	3×10^6	300
10	10×10^6	1 200

5.6 Utilization Categories

5.6.1 Utilization categories as given in Table 2 shall be considered standard for the timer relays.

Table 2 Utilization Categories

Kind of Current	Category	Typical Applications
AC	AC-11	Control of ac electromagnets
DC	DC-11	Control of dc electromagnets

5.6.2 Each utilization category is characterized by the following two characteristics:

a) Load operations, and
b) Rated making and breaking capacity.

5.6.2.1 *Load operations*

The pneumatic relays should ordinarily be able to close, maintain and open circuits which contain an electromagnet, the magnetic circuit of which is open at the time when the actual current is made and closed when the actual current is broken. These conditions are given in Table 3, and the manufacturer shall state the number of load operations applicable, corresponding to the service conditions as given in 7 without repair or replacement of its contacts.

The rated on-load operating cycles shall be according to col 3 of Table 1.

5.6.2.2 *Rated making and breaking capacity*

The timer relays contacts shall have sufficient making and breaking capacity so as to meet the abnormal conditions which may arise, when an electromagnet although energized, fails to close. The conditions to meet such requirements are given in Table 3. The rated making and breaking capacity of a relay corresponds to this duty.

5.6.3 For relays defined by their utilization category, it is not necessary to specify separately the rated making and breaking capacity, and these values depend directly on the utilization category shown in Table 3.

5.7 Rated Time Setting Range

The rated time setting range of the relay shall be stated by the manufacturer.

5.8 Rating Resetting Time

The rated resetting time of the relay shall not be more than 0·04 seconds.

5.9 Mechanical Endurance

The relays shall be capable of performing the operating cycles given in col 2 of Table 1 at the rated switching frequency and under the rated making and breaking conditions.

5.10 Limits of Temperature-Rise

5.10.1 The temperature-rise of the various parts, when tested under the rated conditions and in accordance with **9.2**, shall not exceed those given in Table 4. The temperature rise of insulated coil in air shall not exceed the limits specified in Table 5, when measured by variation of resistance method as given in **8.3.3.2** of IS 13947 (Part 1) : 1993.

5.10.2 The temperature limits for the actuator, in particular for the parts intended to be handled in service, shall be as given in Table 4.

5.10.3 The temperature-rise limits are based on the assumption that the relay shall be operated under the service conditions given in **7**.

The temperature-rise values shall be measured over an ambient temperature not exceeding 40°C.

Table 3 Rated Making and Breaking Capacities Conditions for Making and Breaking Corresponding to the Utilization Categories

(*Clauses* 5.6.2.1, 5.6.2.2, 5.6.3 *and* 9.3.1)

Kind of Current	Category	For Load Operation								For Rated Making and Breaking Capacity							
		Make				Break				Make				Break			
		I	U	Cos ϕ	$\frac{L}{R}$	I	U_r	Cos ϕ	$\frac{L}{R}$	I	U	Cos* ϕ	$\frac{L}{R}$	I	U_r	Cos* ϕ	$\frac{L}{R}$
Alternating current	AC-11	10 I_e	U_e	0·7*	—	I_e	U_e	0·4*	—	11 I_e	1·1 U_e	0·7*	—	11 I_e	1·1 U_e	0·7*	—
Direct current	DC-11	I_e	U_e	—	†	I_e	U_e	—	†	1·1 I_e	1·1 U_e	—	†	1·1 I_e	1·1 U_e	—	†

I = current to be made or broken,

U = voltage before make,

I_e = rated operational current,

U_e = rated operational voltage, and

$\frac{L}{R}$ = time constant.

*The power factors indicated are conventional values and apply only to the test circuits which simulate the electrical characteristics of coil circuits. It should be noted that, for the circuit with power factor 0·4 (normal conditions of use), shunt resistors are used in the test circuit to simulate the damping effect of the eddy current losses of the actual electromagnet.

†Under consideration.

Table 4 Limits of Temperature-Rise

(*Clauses* 5.10.1, 5.10.2 *and* 9.2.3)

Sl No.	Type of Material and Description of Part	Temerature-Rise (Reference Ambient Temperature : 40°C)
(1)	(2)	(3)
i)	Contact parts:	
	a) Copper	45°C
	b) Silver or silver-faced	Limited solely by the necessity of not causing any damage to adjacent parts. In this case of silver-faced contact, the quantity of silver facing shall be such that after carrying out one-tenth of the total number of operations specified for the mechanical endurance test there is still a continuous layer of silver on the contacts. If it is not so, the contact shall be regarded as copper contact.
	c) All other materials and sintered metals	To be specified according to the properties of the metals used and limited by the necessity of not causing any damage to adjacent parts.
ii)	Terminals for external insulated connections	65°C*
iii)	Metallic parts acting as springs	The temperature should not reach a value at which the elasticity of the material is impaired. For pure copper, this implies a total temperature not exceeding 75°C.
iv)	Metal parts in contact with insulating materials	Limited solely by the necessity of not causing any damage to the insulating materials
v)	Manual operating means:	
	a) Parts of metal	15°C
	b) Parts of insulating materials	25°C

*When it is known that the terminals will be connected to bare conductors or conductors insulated with Class A, E, B, F or H materials or provided with a sleeve of such material, a temperature-rise of 65°C is permitted. This temperature-rise is also allowed for the connection of conductors with other insulating materials, provided that the temperature-rise of the conductors does not cause any damage to the insulation at the point where the conductors meet each other or accidentally meet dangerous parts.

Table 5 Tempercture Rise Limits for Insulated Coils

(*Clause* 5.10.1)

Thermal Classification of Insulation	Temperature Rise Limit Coils in Air
(1)	(2)
	°C
Class A	75
Class E	90
Class B	100
Class F	125
Class H	150

NOTE — The insulation classification of the coil is dependent on the use or omission of bonding, impregnating or coating substance in the manufacture of materials or in the treatment of insulated assembly. For instance as stated in Class E, temperature may be used for combination of insulations which may be shown to be capable of being operated at the maximum temperature stated for this class.

6 LIMITS OF OPERATION

6.1 Unless otherwise stated, electro-pneumatic relays shall close with any control supply voltage U_c between 85 percent and 110 percent of its rated value and an ambient air temperature between −5°C to +45°C. These limits apply to dc and ac as appropriate.

The drop-out voltage shall not be higher than 75 percent nor lower than 10 percent of rated control supply voltage U_c.

The close and drop out values specified above are applicable after the coils have reached a stable temperature corresponding to indefinite application of 100 percent U_c. In the case of ac coils, the voltage limits apply at rated frequency.

6.2 Limits of Error

The repeat accuracy of the relay operating time shall be within ± 10 percent between the temperature range of —5°C to + 45°C.

7 NORMAL SERVICE CONDITIONS

7.1 Unless otherwise stated, the relays shall be suitable for use under the following service conditions:

a) Temperature:

  1) Reference ambient temperature for temperature rise measurement 40°C

2) Maximum ambient air temperature	45°C
3) Maximum daily average ambient air temperature	35°C
4) Maximum yearly average ambient air temperature	30°C

b) Altitude up to 1 000 m

c) Atmospheres which are not heavily polluted

d) For installations reasonably free from vibration and when installed with an angle of inclination as specified by the manufacturer.

8 MARKING

8.1 The following information shall be marked distinctly and permanently on every relay preferably in a position where it is visible and legible when the relay is installed:

a) Reference to this Indian Standard;

b) The manufacturer's name or trade-mark, type designation or serial number of relay;

c) Rated time setting range; and

d) Type of operation, 'ON' delay or 'OFF' delay.

8.1.1 The following information shall also be marked elsewhere on the relay:

a) Rated coil voltage,

b) Rated control circuit voltage,

c) Rated operation current of the contact, and

d) Rated frequency.

8.2 BIS Certification Marking

The product relay may also be marked with the Standard Mark.

8.2.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

9 TESTS

9.0 Tests are classified into two classes, namely, type tests and routine tests, as follows:

9.0.1 *Type Tests*

The following shall comprise type tests:

a) Visual Examination (**9.1**),

b) Temperature-rise test on contacts and terminals (**9.2**),

c) Temperature-rise tests on coil (**9.2**),

d) Verification of rated making and breaking capacities (**9.3**),

e) Verification of limits of operation (**9.4**),

f) Verification of resetting time (**9.5**),

g) High voltage test (**9.6**),

h) Repeat accuracy test (**9.7**),

j) Load operation test (**9.8**), and

k) Mechanical endurance test (**9.9**).

9.0.2 *Routine Tests*

The following shall comprise routine tests:

a) Visual examination (**9.1**),

b) Verification of limits of operation (**9.4**), and

c) High voltage test (**9.6**).

9.1 Visual Examination

The timer relays shall visually examined if all parts appear alright and give satisfactory mechnical operation.

9.2 Temperature-Rise Test

9.2.0 *General*

Clause **8.3.3.3** of IS 13947 (Part 1) : 1993 gives the methods of measurement of temperature and precautions to be observed while carrying out the temperature-rise measurements. For conductors other than windings, the temperature of different parts shall be measured by means of thermometers and/or thermocouples at the nearest accessible portion of the hottest accessible spot.

9.2.1 *Temperature-Rise Test for Contacts and Terminals*

This test shall be made on a new relay with clean contacts. However, it shall be permissible before beginning the test, to operate the relay a few times without load.

9.2.1.1 The relay shall be mounted approximately as under usual service conditions and shall be protected against undue external heating or cooling.

9.2.1.2 Temporary connections to the terminals shall be such that no abnormal amount of heat is conducted away from the relay during tests. Unless otherwise agreed between the manufacturer and the user, the type and cross section of temporary connections shall be as specified by the manufacturer, and particulars recorded in the test report.

9.2.1.3 The temperature-rise test on the contacts and terminals shall be made at the rated thermal current. The test shall be made for a sufficient time for the temperature-rise to reach a constant value, but not exceeding 8 hours. In practice, this condition is reached when the variation does not exceed 1°C per hour. Thermal equilibrium shall also be for the relay coil.

9.2.2 *Temperature-Rise Test for Relay Coil*

The coil shall be tested with corresponding rated current flowing through the control and auxiliary contacts for the duration of the test.

9.2.3 *Results*

The temperature shall be measured when thermal equilibrium is reached in both coil and contact circuits and shall not exceed the values specified in Table 4.

9.3 Test for Rated Making and Breaking Capacities

9.3.1 The switching performance tests are intended to verify that the relay is capable of making and breaking an operational current at a given operational voltage under the abnormal conditions of use specified for its utilization category in Table 3. Testing of the switching performance is limited to these conditions. The relay is mounted as in service and the mounting means, as well as the terminal of any contact element stated by the manufacturers as being electrically separated from the one under test, shall be connected to the test circuit as shown in Fig. 1.

When a relay has several identical contact elements, only one of them needs to be tested and this shall be the one most likely to flashover to the frame or adjacent elements.

However, in the case of two neighbouring contact elements stated by the manufacturer as being electrically separated, the switching test shall be carried out on both elements simultaneously and then the test circuit shall be as shown in Fig. 2.

For this test, all parts of the relay normally earthed in service, including its enclosure, shall be connected to the neutral point of the supply or to a substantially inductive artificial neutral permitting a prospective fault current of at least of 100 A. This connection shall include a reliable device (such as a fuse consisting of

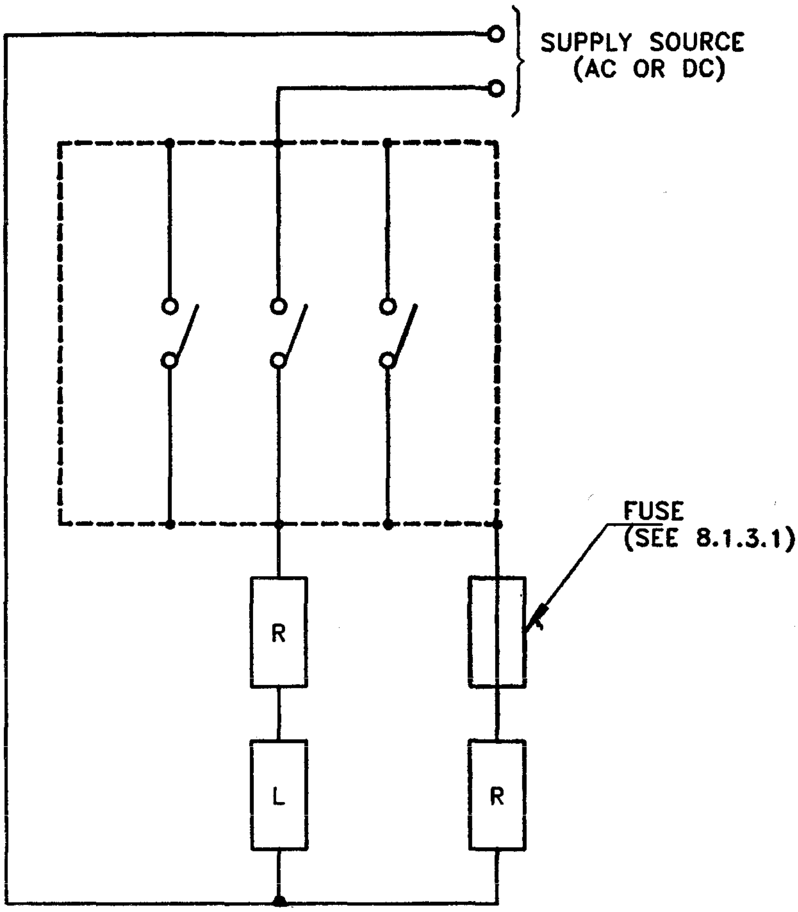
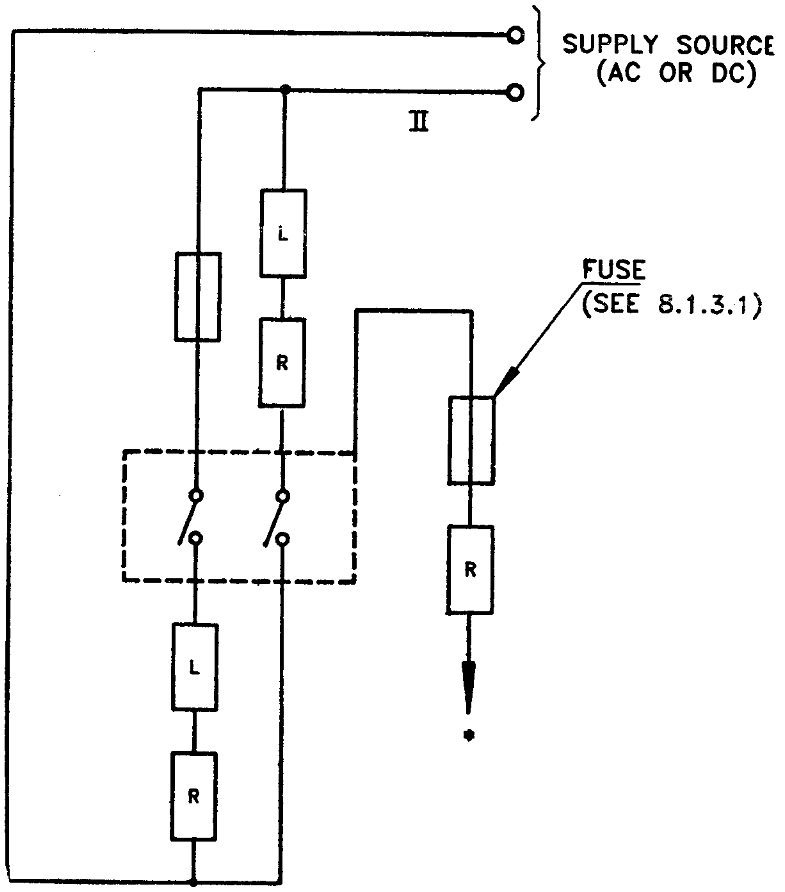


FIG. 1 TEST CIRCUIT



*To be connected ....(both for ac and dc)

FIG. 2 TEST CIRCUIT

copper wire of 0·1 mm diameter and not less than 50 mm in length) for the detection of the fault current and, if necessary, a resistor limiting the value of the prospective fault current to about 100 A.

9.3.2 *Test Circuits*

In order to obtain comparable test results, the following conventional test circuits shall be used:

a) *For ac tests* — The circuit to be used shall consist of an air-cored inductor in series with a resistor, having a power factor of 0·7. The test circuit is to be connected on the load side of the contact element and in no case shall the impedance of the source exceed 10 percent of the total impedance.

   NOTE — This circuit has been selected because of its simplicity as it has been shown to be equivalent, with respect to severity to a contactor coil with the magnetic circuit in the open position. Alternatively test may be performed on the actual load for which the relay is intended.

b) *For dc tests* — The circuit to be used shall consist of an air-cored inductor in series with a resistor to obtain a time constant as agreed to between the purchaser and the supplier. A resistor shall be connected across the complete test circuit to simulate the effect due to eddy currents; the resistance value shall be such that one percent of the test current will pass through this resistor.

   NOTE — Alternatively, the test may be performed on the actual load for which the relay is intended.

The self induction and resistance of the source shall be taken into account when determining the time constant of the test circuit.

NOTE — Attention is drawn to the influence of the source characteristics in addition to those mentioned above. Preference is given to a battery source and particular care is necessary in case of rectifiers, *inter alia* to avoid excessive ripple. For this reason where rectifiers are used, a three-phase bridge rectifier is recommended.

ac and dc test conditions shall be adequately described in the test report, together with the characteristics of the source because of the variations possible in the reproduction of the test conditions specified in the above paragraph.

NOTE — Modifications to the test circuit for dc tests are under consideration.

9.3.3 The timer relay shall make and break the specified values:

a) In case of ac 50 times in succession
b) In case of dc 20 times in succession

The time interval between two successive switching cycles shall be between 5 and 10 seconds.

The duration of the current flow should be at least 0·5 second but be limited to avoid excessive heatings of contacts.

9.3.4 The tests according to **9.3.2** are intended to demonstrate that the contact elements, under the given conditions of operation, will perform in a reasonable manner, without welding, flashover, prolonged arcing or any other signs of distress.

These tests are not intended to give any indication of electrical endurance or contact heating.

9.4 Verification of Limits of Operation

The limits of operation to be fulfilled within the rated time setting range of the relay as declared by the manufacturer (*see* **5.7**).

9.5 Verification of Resetting Time

The time taken by the relay to return to its inoperated position from its operated position by sudden removal of the characteristic quantity shall be determined. This shall not be more than 0·04 second.

9.6 High Voltages Test

9.6.1 *Application of the Test Voltage*

The timer relay under test shall be new and clean and in a dry condition.

The test shall be carried out under circumstances approaching actual service conditions, for example, with conductors attached. The external surfaces of all insulating parts likely to be touched in service shall be made conducting by being closely covered by a metal foil.

The relay shall be capable of withstanding the test voltage applied for one minute as follows:

a) Between live parts of the contact element and parts of the relay intended to be earthed.

b) Between live parts of the contacts element and parts of the relay likely to be touched in service, conducting or made conducting by metal foil.

c) Between live parts belonging to electrically separated contact elements.

NOTE — The main circuit and the control circuit of the relays shall be tested separately if their rated insulation voltage is different.

9.6.2 *Value of the Test Voltage*

A practically sinusoidal voltage of power frequency shall be applied. The rms value of the test voltage shall be as given in Table 6.

Table 6 Values of Test Voltages for High Voltage Test

Kind of Current	Rated Insulation Voltage U_i Range	Electric Test Voltage (ac) (rms)
(1)	(2)	(3)
	V	V
ac and dc	$U_i \leqslant 60$	1 000
	$60 < U_i \leqslant 300$	2 000
	$300 < U_i \leqslant 660$	2 500
	$660 < U_i \leqslant 800$	3 000
	$800 < U_i \leqslant 1\,000$	3 000
dc only	$1\,000 < U_i \leqslant 1\,200$	3 500

9.7 Repeat Accuracy Test

Relay shall be set at four different settings, that is, minimum operating time, maximum operating time and two intermediate position covering the entire setting range and shall be operated 20 times. The time delay shall be measured for each operation. Repeat accuracy shall be determined in acccordance with **3.17**. It shall be within ± 10 percent.

9.8 Load Operation Test

In order to obtain comparable test results, the following conventional test circuits shall be used.

Where there is a probability that deposits of conductive dust or decomposition of insulating material due to switching may seriously effect the insulation between adjacent electrically separated contact elements, these elements shall be tested simultaneously (*see* Fig. 2).

a) *For ac tests* — The circuit to be used shall be as shown in Fig. 3, comprising:

   1) a making circuit consisting of an air-cored inductor in series with a resistor and having a power factor of 0·7, and drawing a current of 10 I_e.

   2) a breaking circuit consisting of an air-cored inductor in series with a resistor, the whole being in parallel with a resistor in which flows about 3 percent of the breaking current I_e, so that the total power factor be of 0·4.

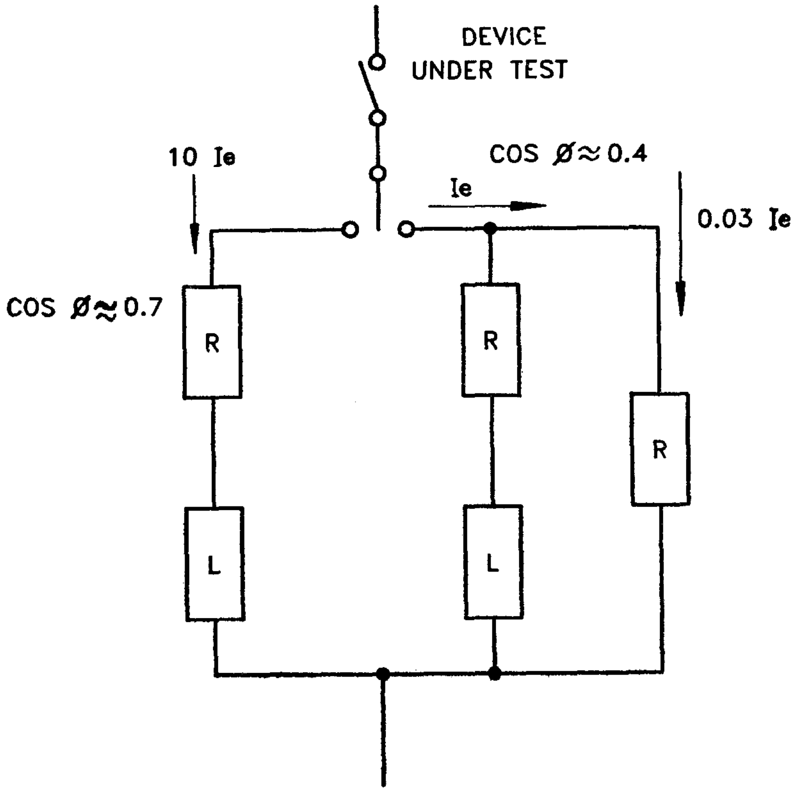


FIG. 3 TEST CIRCUIT FOR LOAD OPERATION TEST

If the contact element has a bounce less than 3 milliseconds, the test shall be made with the simplified circuit as shown in Fig. 4.

b) *For dc test* — The circuit to be used is the test circuit given in **9.3.2** (b).

9.8.1 *Test Porcedure*

The following requirements shall apply wherever possible:

a) *Frequency of Operating Cycles and Load Factor* — The frequency of operating cycles shall be as indicated by the manufacturer but at least as given in Table 1.

The duration of current shall be not more than 50 percent and not less than 10 percent of the duration of an operating cycle. If the test circuit shown in Fig. 3 is used, the duration of current at 10 times I_e shall be such as not to cause overheating.

b) *Criteria of Failure* — A contact shall be deemed to have failed when:

1) the contacts weld,
2) prolonged arcing occurs,
3) it fails to make the current,
4) it fails to open the circuit, or
5) flashover occurs to adjacent contact element or frame.

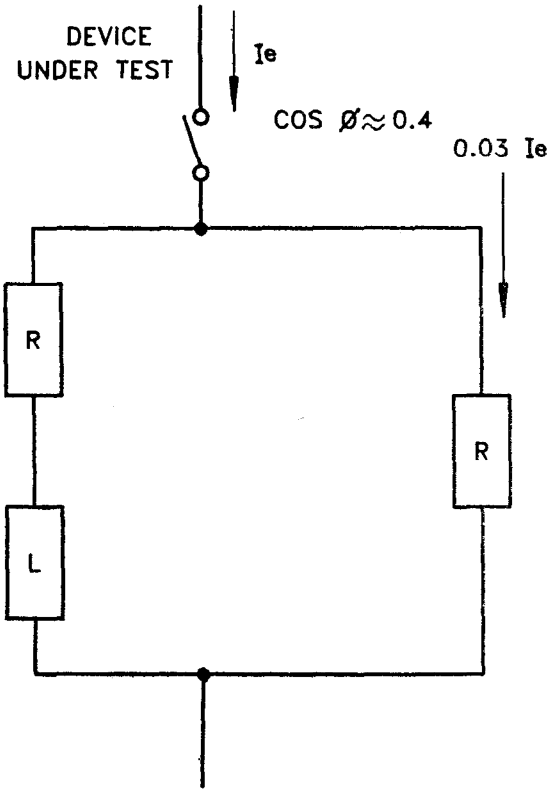


FIG. 4 TEST CIRCUIT FOR LOAD OPERATION TEST FOR CONTACT ELEMENTS WITH BOUNCE LESS THAN 3ms

9.8.2 *Results to be Obtained*

During the test, the contact element shall not show any of the criteria of failure indicated in **9.8.1** (b).

Moreover, at the end of the test, the contact element shall be capable of withstanding again the high voltage test stated in **9.6**.

9.9 Mechanical Endurance

The timer relay shall meet the requirements of **5.9**.

ANNEX A

(*Clause* 4.8)

GENERAL OPERATING PRINCIPLE

A-1 OPERATING PRINCIPLE

A-1.1 In practice it is possible to delay the travel of a moving apart by using an air damper. This principle is utilized in pneumatic timer relays. In practice it is usual to use an elastic chamber connected to the surrounding air by a narrow aperture. When the electromagnet operates or releases, the air chamber expands or contracts, as a result of which it produces a rarefication or excess pressure inside it. The equalising of pressure inside and outside the chamber occurs gradually and that is why the delay is obtained. The duration of the timings cycles is determined by the rate of air travel through the aperture.

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